

South Dakota State University

Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange

SDSU Extension Fact Sheets

SDSU Extension

1973

Sanitary Landfill Site Selection and Operation

Cooperative Extension South Dakota State University

Follow this and additional works at: https://openprairie.sdstate.edu/extension_fact

Recommended Citation

South Dakota State University, Cooperative Extension, "Sanitary Landfill Site Selection and Operation" (1973). *SDSU Extension Fact Sheets*. 679.

https://openprairie.sdstate.edu/extension_fact/679

This Fact Sheet is brought to you for free and open access by the SDSU Extension at Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. It has been accepted for inclusion in SDSU Extension Fact Sheets by an authorized administrator of Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. For more information, please contact michael.biondo@sdstate.edu.

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.



For current policies and practices, contact SDSU Extension

Website: extension.sdstate.edu

Phone: 605-688-4792

Email: sdsu.extension@sdstate.edu

SDSU Extension is an equal opportunity provider and employer in accordance with the nondiscrimination policies of South Dakota State University, the South Dakota Board of Regents and the United States Department of Agriculture.



Sanitary Landfill Site Selection and Operation

**COOPERATIVE EXTENSION SERVICE
SOUTH DAKOTA STATE UNIVERSITY
U. S. DEPARTMENT OF AGRICULTURE**

Sanitary Landfill Site Selection and Operation

by F. F. Kerr, Extension water resources specialist, and
G. R. Durland, Extension agricultural engineer

Site Selection

Meeting legal requirements is the first consideration in selecting a sanitary landfill site. See state law and solid waste regulations for detailed legal requirements.

The second broad consideration pertains to the topography of the land. If gullies or narrow valleys can be found that meet legal requirements they will usually lend themselves well to filling with refuse and leveling by obtaining borrow material from the high areas adjacent to the valley. Man-made or natural depressions on relatively level land would be the next choice. Where neither of the above land features are available, the trench or mound method must be used. Zoning ordinances in effect must be investigated.

Availability of land influences site selection greatly. Whether the land is to be purchased or leased often makes a difference in its availability. Large landowners may not wish to sell a parcel of land for the facility, but they may welcome a chance to lease it, especially if the completed landfill will result in improved topography for farming or other purposes.

Site location in relation to quantity of waste generated is the consideration that calls for the most study. This is especially true if the site is to serve a geographic area embracing several communities plus a rural area. Hauling time constitutes a large part of the cost, so it is important that a big percentage of the waste is generated within the smallest possible hauling radius.

Roads over which delivery trucks will move are an important factor, not only from the standpoint of being all weather roads, but also from the standpoint of the traffic flow pattern.

Kinds of wastes and percentage of each should be considered. For example, the necessity of handling livestock processing wastes that have an inherent odor will influence location.

Although a well operated sanitary landfill does not constitute a serious nuisance, it should not be located near residences. Even the noise of operating heavy equipment would make this undesirable.

Some borings should be made prior to final selection to find depth to water and to investigate soil permeability. Water table elevations need to be definitely determined so that legal requirements will be met. Adequate cover material of acceptable quality must be available. In areas where soil surveys are complete, much of this data will be readily available.

Drainage away from the operating site as well as from the completed site is a must. It is often possible, however, to construct this drainage pattern when operations start since large amounts of cover material need to be stockpiled, especially for winter use.

Acreage Needed

In this series of fact sheets, a waste yield of 4.25 pounds per person per day is assumed. This assumption is considered as a state average. For planning purposes it may be assumed that facilities handling mostly household wastes will receive about 3.5 pounds per person per day. The most commercialized and industrialized areas in the state are not likely to exceed 5.5 pounds per person per day. The national average per person yield is increasing; however, the yields shown here are believed to be realistic for South Dakota.

Some communities have past records of refuse yields that can be used. In absence of such records a judgment figure somewhere between 3.5 and 5.5 must be made.

Having arrived at a yield figure, the acreage needed becomes a function of (1) the population to be served, (2) the practical depth of fill for the site in question, and (3) the desired life of the site. Good compaction of the waste material will extend the life of the site.

An example of the estimation procedure appears below:

1. Assume a population of 30,000 people to be served.
2. Assume a fill depth of 20 feet.
3. Assume a yield of 4.25 pounds/person/day.
4. Tons generated per year would be:
 $4.25 \text{ pounds} \times 30,000 \times 365 \text{ days} = 46,537,500 \text{ lb/year}$
5. $46,537,500 \div 2,000 = 23,269 \text{ tons/year}$

6. One ton (including fill material) averages .0018 acre feet*.

7. $23,269 \text{ tons} \times .0018 = 41.88 \text{ acre feet per year}$. $41.88 \div 20 \text{ feet of depth} = 2.10 \text{ acres filled per year}$.

8. If you wish to design for a 10 year life it would be necessary to purchase about 21 acres for fill purposes alone.

9. To allow ample borrow area, roads, parking, etc., it would be advisable to increase this by 30 to 50 percent depending on the disposal method to be used. The trench method requires little, if any, borrow area, while the mound method requires a great deal.

*An acre foot as used here would mean one acre of compacted and covered waste one foot deep.

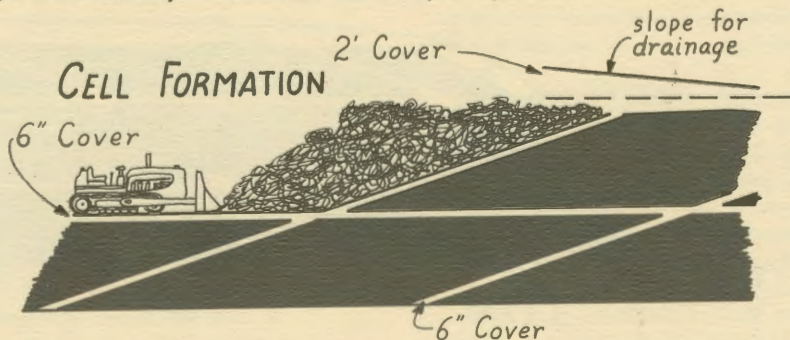
In rapidly growing areas, consideration should also be given to probable population increases over the design life of the facility.

Sanitary Landfill Methods

There are four methods of disposing of wastes in sanitary landfills, although "ways of doing it" might be more descriptive since all four imply the basic principle of cell formation as shown in Figure 1. The method employed is largely dictated by the topography of land available.

The trench method as shown in Figure 2 is adaptable where available land is flat and the water table is low. Cover material is never a problem, since soil excavated in construction of the trench is readily available. The entire trench need not be excavated at one time. Trench excavation and filling operations may take place concurrently, although enough trench excavation to accommodate fill during winter months would be necessary in South Dakota. Top soil should be stockpiled for use in closing operations when the trench is full.

Fig. 1. All sanitary landfill methods use principle of cell formation.



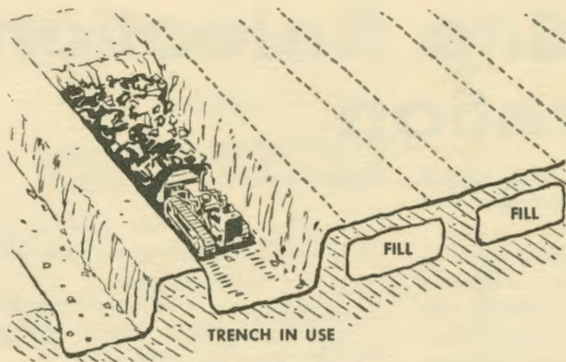


Fig. 2. Trench method works best on flat land.



Fig. 3. Area method may use natural depressions or borrow sites.



Fig. 4. Gully method may improve rough unusable land.

Accumulation of water in the trench during prolonged periods of rainy weather can be a serious problem. Equipment capable of pumping out the water should be provided. Drainage away from the trench will insure the need for pumping only that rain that falls in the trench itself.

The area method shown in Figure 3 may take advantage of borrow pits or natural depressions in the ground. Use of abandoned gravel pits should be avoided because of likely ground water contamination. Adequate protection of ground water must be insured regardless of the method used. Borrow material for cover may not be as readily available with the area method as with the trench method.

The gully or narrow valley method shown in Figure 4 is a variation of the area method. Cover material may be taken from the high ground on the sides of the valley. This method frequently changes very rough unusable land into land desirable for many purposes.

The mound method shown in Figure 5 is sometimes referred to as "above ground trenches." Where available land is level and water tables are high, this method becomes the only choice. Operating costs are usually higher, largely because of difficulty in finding nearby borrow cover material without getting into ground water.

Operations

Equipment Needs

Equipment selection is one of the most important steps in establishing a sanitary landfill. No matter how well everything else may be planned and organized, if the equipment selection is not satisfactory, the landfill operation will not be successful. Despite this importance there is no hard and fast rule to follow for a given landfill. Factors that determine the size, type of equipment and the attachments needed for this equipment are the amount and type of refuse, the topography and the type of landfill. Undersized, inadequate or unreliable

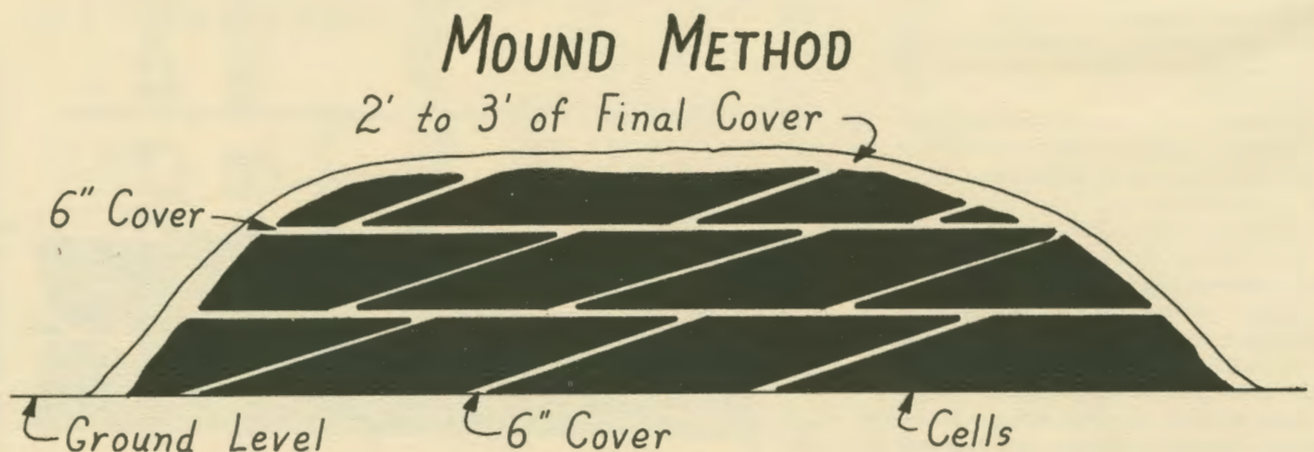


Fig. 5. Mound method may be only alternative for some landfills. It is more expensive to operate.

equipment may result in breakdown, high cost of operation, improper landfill operation such as poor compaction, and the development of health hazards or nuisances.

Equipment must be available at the landfill site every day that refuse is deposited there. This factor alone may make it necessary to purchase equipment with landfill operation as its sole use. Other options, providing the equipment is available when needed, are to purchase general purpose equipment that will be used elsewhere, or rent or lease equipment. It is also necessary to have a source for backup equipment in case the principle machine is laid up for repairs.

Equipment should also be obtained with the future in mind. Refuse production is increasing more rapidly than the population is growing, therefore it would be wise to plan for 25 percent more refuse than is now being generated. This will allow efficient use of the machine in future years.

There are several different types of equipment to be considered. Their cost and description of their functions is as follows:

1. **Track-type loader;** 1¼ yd, \$28,000
2¼ yd, \$36,000
3 yd, \$54,000

If only one piece of equipment is to be kept at the landfill site, the track-type loader is the most usable. It is capable of doing all jobs necessary, but does not do them as well as specialized equipment. This machine works particularly well on trench fills as it has excellent capability for excavating and compacting directly adjacent to the wall of the trench. This machine can economically move cover material 300 feet.

2. **Track-type dozer (D-7 Size);** \$60,000.

This machine (Figure 6) is capable of spreading and moving fill material short distances and does a fair job of compacting. It will spread refuse better than a track-type loader.

3. **Wheel-type loader;** 1¼ yd, \$27,000
4 yd, \$52,000

The wheel-type loader (Figure 7) is a very mobile piece of equipment with about the same capabilities as the track-type loader. It does a better job of compacting than does the track-type. Because of its mobility, it is considered a good dual purpose machine as it could be used in the sanitary landfill and also easily driven to other maintenance jobs. It does not have the traction of a track-type machine, and therefore some excavating and dozing ability is lost, particularly on wet or icy ground.

4. **Steel-wheel compactor;** \$50,000

This machine (Figure 8) does an excellent job of spreading and compacting the refuse. It is a single purpose machine. Other equipment is necessary for the excavating of the landfill.

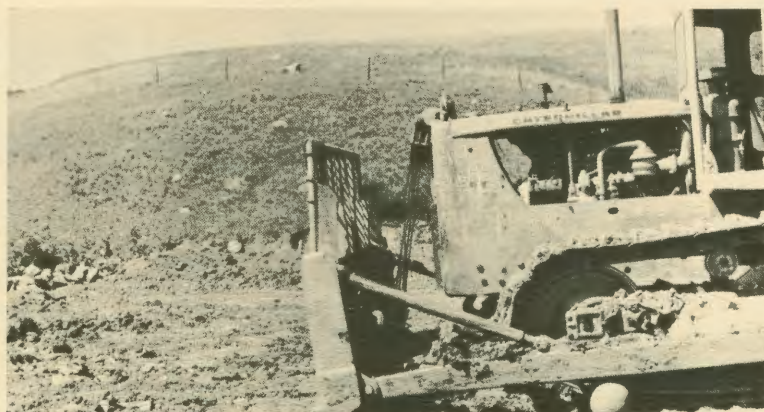


Fig. 6. Track-type dozer spreads refuse well, is fair at compacting.



Fig. 7. Wheel-type loader is very mobile, good at compacting.



Fig. 8. Packers with wheel lugs are good at spreading, compacting.



Fig. 9. Refuse on right awaits the spreading which is finished in center.

5. Self-loading elevating grader;

11 yd, \$ 48,000
22 yd, \$ 90,000
32 yd, \$140,000

This machine is excellent for excavating, stockpiling fill material, and covering compacted refuse. It is also quite mobile, so it can be easily moved to other jobs. It is well suited for the trench method and for landfills where a large amount of cover material is needed or when it must be transported over distances of 1000 feet or more. It is designed only to move dirt, so other units must be used for spreading and compacting the waste.

The final decision when selecting equipment must be based on what equipment is needed to properly excavate the site, spread and compact the refuse, and cover the compacted refuse. It might be possible that presently owned equipment can be made available to the landfill when it is open for depositing refuse. A better solution might be to purchase equipment primarily for landfill use and earmark existing equipment as "back-up" machinery.

Equipment shelter should also be provided. Shelter will not only protect the equipment from the elements, but it also provides a place to service and repair the machines and to store spare parts, tools and other supplies.

Weighing refuse provides the most equitable means of establishing fees for refuse disposal and also provides a basis for a cost analysis of the landfill operation. Basing the amount of refuse on volume is a less accurate means of measuring incoming refuse, although quite often it is an acceptable method.

Equipment Operations

Over-heating of landfill equipment is very common, so the radiator must be protected from paper or plastic films that might clog it. Engine enclosure packages, which include side screens and perforated hood, provide protection from material getting in the radiator or on the motor. Radiators must be cleaned periodically. Reversible fans are desirable on the engine and should be operated in suction position most of the time to keep the engine compartment clean. The fan blades can be reversed to blow materials out of the radiator when it becomes clogged.

Refuse is considerably lighter in weight than soil, therefore a "sanitary landfill" bucket or blade will allow more efficient operation of a tractor. The attachments allow the tractor to move more volume than would be possible with the standard bucket or blade attachment.

Loaders should be equipped with tires that are protected from punctures such as tires with steel breakers under the tread. Foam filled tires can be used, but these are

2 or 3 times more expensive than conventional tires.

Compact and Cover Requirements and Methods

Depositing of the refuse must be controlled. This means that access to the landfill must be limited to those times when an attendant is on duty and only to those authorized to use the site for the disposal of refuse. Otherwise, indiscriminate dumping and scavenging quite often occur. The unloading of the refuse must also be directed by the attendant. Coordinating the placement of the refuse in small unloading areas near the spreading and compacting operation will reduce work, minimize the scattering of refuse and expedite the unloading of the collection vehicles. To facilitate the proper placement, appropriate signs should be posted to clearly indicate where vehicles should unload. In a small landfill, the equipment operator may have to direct the unloading.

After the refuse is deposited, it should be spread and compacted in shallow layers that do not exceed 2 feet in depth (Figure 9). Layers deeper than this will not be uniformly or completely compacted and can allow openings for insects and rodents. Additional layers can be spread and compacted until the "lift," which is the depth of the compacted refuse fill, is built up to a height of no more than 8 feet. Construction of a fill in well-compacted lifts of no more than 8 feet in depth minimizes settlement, surface cracking, and release of odors. Lifts of less than 8 feet will not make maximum use of available land but provide for earlier re-use of land.

Cover material, at least 6 inches in depth, should then be placed over the compacted refuse (Figure 10). This should be accomplished by the end of each working day. This covering is necessary to prevent fly and rodent attraction, blowing of papers, production of odors, fire hazards and unsightly appearance. When operations will not continue the following day, the fill should have an intermediate cover of 12 inches placed over it. A 1-foot layer of properly compacted and maintained cover will prevent health hazards or nuisances until the next lift is placed on top, for no longer than 1 year.

The final cover should be of suitable cover material and be spread and compacted into a layer at least 2 feet in depth. This should be placed no later than 1 week following the placement of refuse within that final portion. This 2-foot cover will prevent emergence of insects from compacted refuse, minimize the escape of odors and gases, and prevent rodent burrowing. It also provides an adequate bearing surface for vehicles and sufficient thickness to still provide a sound cover in the event of settling or erosion. The cover should be continually inspected and repaired, if neces-

sary, until the entire landfill is completed and there is no longer evidence of settling. Major settling occurs during the first year; some settling may continue for several years.

When existing dumps are converted into sanitary landfills it might be necessary to exercise a certain amount of additional rodent control. This is usually in the form of controlled poisoning by a qualified rodent control firm. This additional rodent control should not be necessary in the case of a new landfill that is properly maintained and completed, but if it does become necessary, then it should be completed within 24 hours.

Large items such as car bodies, refrigerators, trees and large tires are sometimes difficult to dispose of in a routine manner, particularly at small landfills. Large landfills usually have adequate equipment to handle this material routinely with other refuse. Small landfills may have to provide an alternate location, away from normal refuse, where these large items can be unloaded for eventual disposal.

Manpower Needs

Because of the great variety of situations encountered at different landfills it is not possible to set up a schedule for manpower needs. Small landfills that are only open 2 or 3 days a week may only need an equipment operator who will also have to direct the people unloading refuse to the proper location. Some medium sized landfills may get by with a husband-wife team, where he will handle the equipment and the wife will serve as an attendant at the gate directing the refuse depositors. Large landfills may have a full time attendant at the gate plus several equipment operators. Therefore, each landfill operation will have manpower needs based on its respective situation. Communications—either radio or telephone—should always be provided for personnel working at the landfill site.

Winter Operations

A sanitary landfill must be operated in winter as in summer. Therefore, cover material must be available in a movable condition so refuse can be covered daily. This means adequate cover material for winter operation should be stockpiled, usually in the fall when it is more apt to be dry. This stockpile should be covered with straw or other material to minimize freezing.

Paper Control

A sanitary landfill must dispose of refuse in a sanitary and nuisance-free manner. Therefore, a portable fence near the working area and a good job of policing the area are necessary to catch and eliminate papers and other light material that might blow away. When covering light refuse material, mixing cover material with the refuse will help to control the blowing papers. The



Fig. 10. Six inches of soil is spread over compacted wastes to form a "cell."

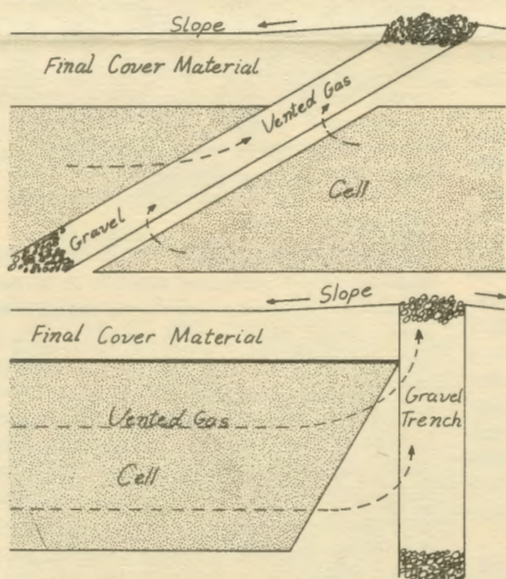


Fig. 11. Gravel vents or gravel filled trenches control lateral gas movement.

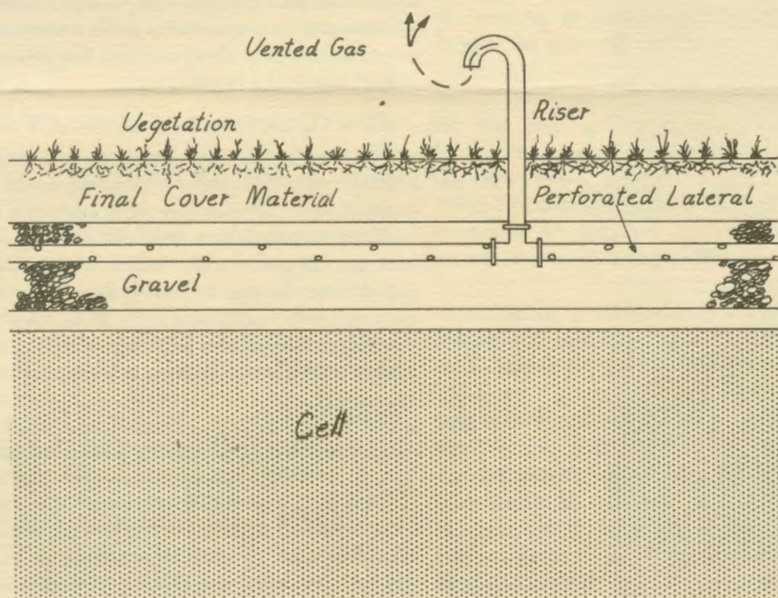


Fig. 12. Pipes inserted through an impermeable top cover and connected to collecting laterals in gravel trenches also vent gases.

portable fence and surrounding area should be policed daily to collect and place in the fill all refuse that may have scattered around the site.

Fencing Needs

The entire landfill area should be fenced, with gates on access roads, to prevent promiscuous dumping, scavenging or entry of domestic animals. The gate should be locked when the site is closed. The gates should be attended when the site is open, to control the location of refuse disposal and unauthorized entry.

Portable fences should be located downwind from the working area.

Fire Protection

The site should be provided with fire protection. If possible, adequate water should be available and accessible on the site. A stockpile of dirt should also be available for extinguishing fires. If an organized fire department is located nearby it should be contacted to arrange for immediate service if needed.

Control of Gas Movement

Carbon monoxide and methane gases are products of decomposition in a sanitary landfill. Methane gas is a colorless and odorless gas and is highly explosive in concentrations of 5 to 15 percent in the presence of oxygen. In some cases methane has moved into sewer lines and nearby buildings in explosive concentrations. Gas will also kill vegetation by excluding oxygen from the root zone.

Carbon dioxide is also a colorless and odorless gas, but is not combustible. It is heavier than air and soluble in water. It can react with water to form carbonic acid which can dissolve mineral matter. If this happens, the mineral content (hardness) of water can increase, as has been found in wells located near landfills.

Usually no problem will arise if the gas can disperse into the atmosphere. If the fill has an impermeable cover the gas will often move laterally through a more permeable material in an attempt to vent into the atmosphere.

Therefore, controlling the movement of these two gases and traces of hydrogen sulfide and other odorous gases is important in landfill design. The natural soil, hydrologic and geologic conditions of the site may provide adequate control of gas movement, but if they don't other control methods must be used.

Two general control methods—permeable and impermeable—can be used. In the permeable method the lateral gas movement can be controlled by using a material that will always be more permeable than the surrounding soil. Gravel vents or gravel filled trenches (Figure 11) have been used. The trenches should be deeper than the fill to insure that they will intercept all lateral gas flow and constructed so that

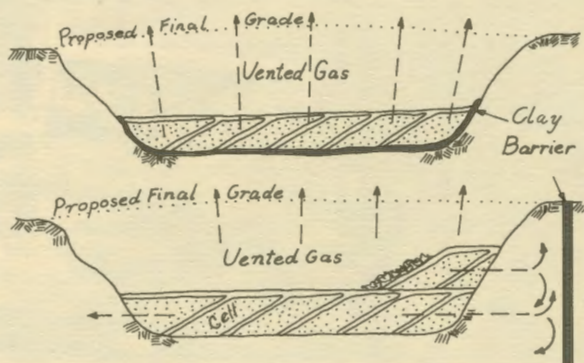


Fig. 13. A clay liner or a clay curtain will block underground gas flow.

they drain naturally. The surface of a trench should be graded to prevent infiltration and subsequent clogging by adjacent soil, and should be kept free of soil and vegetation which will retain moisture and hinder venting.

Another method to control gases is to install a vent pipe through the impermeable cover (Figure 12). Collecting laterals placed in shallow gravel trenches within or on top of the waste can be connected to the vertical riser. The sizes and spacings required have not been established but depend on rate of gas production, total weight of solid waste and the gas permeability of both the cover and the surrounding soil. These pipe vents should not be located near buildings, but if this is unavoidable, the vents should discharge above the roof line. Suction pumps can be used to mechanically move the gas, but this is a costly method and requires frequent maintenance.

The impermeable method of controlling gases prevents the movement of gases through the soil surrounding the landfill. By using materials that are more impermeable than the surrounding soil, a barrier can be established that will contain the gas and vent it through the top cover of soil or simply block the flow of gas. The most common method, and probably the most practical, uses compacted clay for the barrier. The clay must be kept moist to prevent it from shrinking and cracking. The clay can be placed as a liner in an excavation or be installed as a curtain wall to block underground gas flow (Figure 13). A layer of clay 18 to 48 inches thick should be adequate. It must be continuous and not penetrated by the solid waste or surrounding soil or rocks. The liner should be constructed as the fill progresses to prevent the clay from drying and cracking from prolonged exposure to air.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. Duane Acker, Director of Extension Service, South Dakota State University, Brookings. The South Dakota Cooperative Extension Service offers educational programs and materials to all people without regard to race, color, religion, sex or national origin, and is an Equal Opportunity Employer. 5M-10-73-File 5.5-1308

Sanitary Landfill Site Selection and Operation

COOPERATIVE EXTENSION SERVICE
SOUTH DAKOTA STATE UNIVERSITY
U. S. DEPARTMENT OF AGRICULTURE

